

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS, SEPTEMBER, 1916.

By EDWARD H. BOWIE, Supervising Forecaster.

[Dated: Weather Bureau, Washington, October 21, 1916.]

Over the Alaskan and Aleutian areas the pressure during the month averaged near the normal, with marked depressions over the Aleutian Islands on the 8th-9th, 14th-19th, 21st-22d, and 24th-26th, and marked excesses during the 1st-6th, 10th-12th, 20th, 23d, and 28th-30th, while over Alaska there were well-defined lows over the southern coast on the 2d-3d, 17th-19th, and 23d-26th, and over the interior on the 5th-9th, 16th-19th, and 22d-26th. The pressure averaged above the normal continuously during the month, save on the 21st, at Honolulu, Hawaii. Over the western portion of the North Atlantic as shown by the barometer readings from Bermuda, the pressure was above the normal almost continuously.

In the United States, the lows were mostly of northern origin. One made its first appearance north of the Great Lakes, five were of the Alberta, three of the northern Rocky Mountain, one of the South Pacific, and three of West Indian or tropical type. One of the latter did not, however, reach the American continent. The lows of September were not attended by violent winds. This was especially true of the tropical disturbances that reached the South Atlantic coast. One of these recurved east of the Bahamas and passed near Bermuda on the 23d, attended by destructive gales. The highs during the month were eight in number, of which one made its first appearance north of the Great Lakes, two in Alberta, two in the northern Rocky Mountain region, and three off the North Pacific coast.

DISTRICT WARNINGS DURING SEPTEMBER.

Washington district.—The month opened with a tropical disturbance over the western Caribbean Sea and on the morning of the 1st the following advisory message was sent southern ports and distributed by wireless to vessels at sea:

The tropical disturbance over the Caribbean Sea is apparently central off the east coast of Yucatan and moving westward. Thus far it has not been attended by dangerous winds, although winds of moderate gale force have prevailed during the last 24 hours in the Florida Straits, the southeast portion of the Gulf of Mexico, and the Yucatan Channel.

On the morning of the 2d, advisory information to the effect that

The tropical disturbance has apparently crossed the Yucatan Peninsula to the Bay of Campeche, whence it will advance westward into Mexico and be dissipated.

was disseminated to southern ports and by wireless to vessels at sea.

On the morning of the 5th, northeast storm warnings were ordered for the South Atlantic coast between Savannah and Cape Hatteras and in the evening of the same day the display was extended northward to the Virginia capes. The necessity for the warnings arose from the presence of a disturbance of unknown intensity

off the Georgia coast. The center of this disturbance passed inland near Wilmington, N. C., during the night of the 5th and thereafter lost intensity. Winds of moderate gale force off the South Atlantic coast attended this disturbance during its march northward. On the 11th information to the effect that there were indications of a disturbance east of the Bahamas was sent Atlantic and Gulf ports, and on the morning of the 12th northeast storm warnings were ordered for the Atlantic coast between the Virginia capes and Jupiter Inlet. The center of this disturbance crossed the coast line near Jacksonville during the night of the 12th and thence moved westward into Alabama. Winds of gale force prevailed off the South Atlantic coast while the disturbance was offshore.

On the evening of the 21st northwest storm warnings were displayed on western Lake Superior, at which time a disturbance of considerable intensity was immediately north of Minnesota, but no unusual winds attended this disturbance. On the 20th information was issued to the effect that there were indications of a disturbance east of the island of St. Kitts, West Indies, and on the 23d advices were issued to the effect that this disturbance was recurving east of the Bahamas and moving toward Bermuda. The storm passed northeastward near Bermuda during the night of the 23d and was there attended by destructive gales.

On the morning of the 27th southwest storm warnings were displayed on Lakes Huron, Erie, and Ontario, and strong southerly winds occurred on these lakes during the afternoon and night of this day. On the 30th southwest storm warnings were displayed on Lake Superior, northern Lake Michigan, and extreme northern Lake Huron, at a time when a disturbance of marked intensity was central over Manitoba, Canada. This disturbance moved northeastward toward Hudson Bay unattended by winds exceeding 40 miles an hour in the region where warnings were displayed.

Frost warnings were required on a number of days during the month, the principal issues being as follows: 1st and 2d, for exposed places in upper Michigan; 3d, for exposed places in northern New England, northern and central New York, and the cranberry marshes of New Jersey; 14th, for upper Michigan; 15th, for the upper lakes region, Indiana, western and central Ohio, and exposed places in Kentucky; 16th, interior of the Middle Atlantic States, the New England States, and the Ohio Valley; 17th, region of the Great Lakes, the upper Ohio Valley, and Indiana; 18th, region of the Great Lakes, the mountain districts of the Middle Atlantic States, the interior of New York, and northern New England; 19th, interior of New York and New England and the cranberry marshes of New Jersey; 21st, exposed places in upper Michigan; 23d, region of the Great Lakes; 24th, New England and the cranberry marshes of New Jersey; 25th, northern New England, northeastern New York, and the cranberry marshes of New Jersey; 29th and 30th, for the region of the Great Lakes, the Ohio Valley, and the Middle Atlantic and New England States.

Chicago district.—The frost-warning service throughout the month was the most important feature of the forecast

work in the Chicago district. On the 2d frost occurred in portions of the cranberry region of Wisconsin and quite generally throughout the northwestern portion of the State and in extreme northeast Minnesota. Warnings, however, were not sent in advance, because unsettled and showery weather was expected, but a rapid movement of a cold high area from Manitoba cleared away the clouds and caused a considerable fall in temperature. Very little damage, however, was reported.

The first high area that promised general frost appeared in British Columbia on the 13th, and warnings of frost were sent on that day to Montana, Wyoming, the Dakotas, northwestern Minnesota, and northwestern Nebraska: also an advisory message to the cranberry and tobacco interests of Wisconsin, as follows:

A cool wave in the northwest will advance eastward, causing unseasonably low temperatures in Wisconsin Thursday night and Friday morning. Later advices will be sent to-morrow.

This advice gave these interests an additional day in which to prepare for the coming severe conditions, and was especially important to the tobacco growers. This cool wave moved eastward and southeastward over the entire district during the next two days, and frost warnings were issued for all regions threatened on the 14th and 15th. The ensuing temperatures were abnormally low for the season.

Another cool wave, but less general, immediately followed on the 17th and 18th, as an area of high pressure moved southeastward from the Canadian northwest. In this case the cold was not felt to any marked degree over Kansas, Missouri, and southern Illinois. The temperatures, however, were again unseasonably low in the western lake region and upper Mississippi valley, and warnings were issued well in advance.

On the 20th another high pressure area appeared in British Columbia which moved southeastward over the district. The frost was not of much importance except in the Northwestern States, and warnings were sent in advance for these sections. The temperature, moreover, was not nearly so low as in the preceding cool waves. This high area on the night of the 23d caused severe frost in the cranberry marshes of Wisconsin and warnings were issued to the various stations in the State on that day.

On the 27th another cool high area appeared in British Columbia and moved directly southeastward over the Chicago district. Warnings were issued on the 27th and 28th in advance of the wave: in fact, warnings were sent to all points in this district, except southeastern Illinois, which was not affected.

The cranberry growers of Wisconsin represent practically the only industry in this district that has full protection from frost, as water is available for flooding their marshes in advance. As a consequence, these growers suffered very little loss from frost.

The tobacco growers sometimes smudge, but, as a rule, they either cut the plants or take their chances with the frost, risking the subsequent injury and deterioration. In some cases this season the growers took the latter course, but even though severe injury occurred the money value of the crop is higher than in 1915. In cutting the plant before it is matured there is, of course, a loss also. It is estimated that the total loss to the Wisconsin tobacco growers this year either by frost or by lack of maturing because of cutting in anticipation of frost ranges from \$500,000 to \$1,000,000. However, the Weather Bureau did its full duty in issuing warnings in advance.

The Chicago office has the duty of issuing fire-weather warnings to the forested regions of the Northwest, but because of the favorable conditions prevailing there was

practically no demand for this service during the month. Warnings, however, were issued on September 3 for Minnesota, South Dakota, and Wyoming for fresh to strong winds for the ensuing 24 hours. A message was also sent to the observer at Yellowstone Park on September 25, advising him of moderate winds, as he had telegraphed that a fire was raging in the park.

Long-range forecasts were sent to the observers at Springfield, Ill., and Helena, Mont., each for a week in advance, in connection with State fairs held in their cities. These forecasts were almost fully verified. The messages were as follows: Sent to Springfield, Ill., on September 19, "Fair weather with somewhat higher temperature indicated for balance of week." Sent to Helena, Mont., on September 25, "Conditions doubtful Tuesday, but probably mostly fair weather after that date and rather cool balance of week." The following message was also sent to the manager of the Missouri State Fair at Sedalia, Mo., on September 23, in response to his request of the same date: "Conditions favorable for showers Sunday and Monday, with somewhat higher temperature followed by fair and rather cool balance of week." However, because of slow moving conditions from the west, this forecast failed partly of verification.—*H. J. Cox.*

New Orleans district.—On the morning of September 12 an area of moderately high pressure, central over Colorado, was attended by low temperatures in Colorado, northern New Mexico, and western Kansas, with light frost in southern Colorado and northern New Mexico. Frost was predicted for extreme northwestern Oklahoma and the extreme northern portion of west Texas. In the ensuing 24 hours the area of high pressure weakened slightly in intensity and temperatures did not change materially, the minima being 50° or slightly below in the small area for which frost was forecast.

On September 14 a pronounced area of high pressure, central over northern Wyoming at 8 a. m., was moving southeastward, and frost was forecast for western Oklahoma and the Texas Panhandle. Temperatures of 40° and slightly higher were recorded on the morning of the 15th, but no frost was reported. As the possibility of frost occurrence was still evident on the 15th, frost was predicted for northern Oklahoma and extreme northwestern Arkansas, and temperatures in the forties were generally recorded on the 16th at stations in the area included in the warning. A further temperature fall was prevented by the rapid eastward movement of the high-pressure area.

On the 28th the pressure distribution in the western half of the country resembled that of September 14, but on the 14th the pressure diminished from the center of high pressure to the east Gulf coast, while on the 28th a shallow trough of low pressure extended from the Lake region southwestward over the lower Mississippi Valley to the west Gulf coast. Further, the temperature fall over the southern slope and Plains States was more uniform and decided on September 28 than on the 14th. On the 28th frost was forecast for the Texas Panhandle and northwestern and north-central Oklahoma. Light to heavy frosts occurred on the 29th, as predicted, and light frost also at Bentonville, Ark.

Frost warnings were issued on the 29th for Arkansas and eastern Oklahoma, and the warning was fully justified, frost being general in Arkansas on the 30th, with heavy frost at a few places, and frost temperatures occurred in eastern Oklahoma.

Small-craft warnings on the Texas coast were ordered September 28, and fresh northerly winds occurred that

afternoon and night. There were no higher wind velocities during the month and no storm warnings were issued.—*R. A. Dyke.*

Denver district.—The month was notably free from general or severe frosts. A warning of heavy frost for parts of eastern Colorado was issued on the 14th and warnings of light frost for parts of the district were issued on the 11th, 12th, 14th, 15th, 23d, 26th to 29th, inclusive.

On the morning of the 11th high pressure overlay Wyoming and the Great Basin, while low pressure prevailed in New Mexico and adjacent regions. Frost warnings were issued for Utah, northern Arizona, and northern and western Colorado. The front of the high-pressure area moved southeastward as expected, causing light frosts over the greater part of the area, with freezing temperatures in a few localities in the fruit districts of western Colorado. On the 12th warning of local frost in northern New Mexico was included in the regular forecast; it is probable that light frost occurred in the high districts. An area of high pressure overlay the northeastern Rocky Mountain slope on the morning of the 14th; its movement was southeastward, causing frosts in eastern Colorado and northeastern New Mexico, part of the area for which warnings had been issued. On the 23d frost was predicted for the high districts of Utah and was probably verified as the skies cleared. On the 26th a barometric trough extended from Arizona northeastward to Lake Superior, while high pressure overlay Oregon with the front of the high extending along the west side of the Continental Divide. Warnings of frost were issued for Utah, northern Arizona, western and northern Colorado, and northern New Mexico. Frosts occurred in parts of Utah, in northern Arizona, northwestern New Mexico, and locally in the fruit districts of western Colorado. In this case the warnings were somewhat premature, as the high did not continue southeastward but moved first north then east to Montana and thence southeastward on the east side of the Continental Divide. Warnings of frost were repeated on the 27th for Utah, Colorado, and northern New Mexico; they were fully verified in northeastern Colorado and locally in the rest of Colorado and Utah. Eastern Colorado, and northern and eastern New Mexico were still under the domination of the high on the morning of the 28th and warnings of frost were issued for these districts and were verified except in extreme southeastern New Mexico. The warning of the 29th for local frost in northern and eastern Colorado was verified only in a few localities, as the area came quickly under the influence of a northern low.—*F. H. Brandenburg.*

Portland district.—Normally quiet weather obtained during September over this district. The mean temperatures were above normal west of the Cascade Mountains and in northeastern Washington, and correspondingly below normal in the remainder of the district. Less than half of the usual rainfall occurred, and most of this fell during the first week. On this account there was a greater fire hazard than during August, and general fire weather warnings were issued on the 13th, 16th, and 20th, being disseminated by telegraph, telegram, and post card as usual. The forest fire patrols at the close of the month were still on duty in southern and eastern Oregon, eastern Washington, and Idaho.

No storm or small-craft warnings were issued, although they would have been justified on the 14th, when the verifying velocity was reached at Tatoosh Island, and again on the 26th, when similar conditions obtained at Tacoma. Winds of 26 to 36 miles from the northwest occurred on five days at the mouth of the Columbia River during afternoons following atmospheric conditions shown

on the morning maps that would hardly have justified the sending out of small-craft warnings. These high winds were largely local in character, and it is believed no damage resulted.

Frost warnings were issued on six dates, of which three were verified, two were partially verified, and one was a failure. There were three dates on which light frost formed in limited areas for which no warning had been issued.

On the 1st low pressure obtained over the Pacific slope, with high pressure east of the Rocky Mountains. On the 2d the northwestern "low" crossed the northern Rockies and was followed to the northern California coast by a high-pressure area, causing rains throughout most of this district. Similar conditions prevailed on the 7th, 8th, and 9th; on the last date a high-pressure area began to overspread the north Pacific slope, and generally fair weather followed until a strong high-pressure area on the 24th reached the Oregon-northern-California coast, while the pressure over British Columbia was low, resulting in southerly winds and rains on the following two days. This high subsequently moved northward and a portion moved inland, becoming the strong eastern high of the latter part of the month, while generally fair weather prevailed over the Northwest.—*T. F. Drake.*

San Francisco district.—Light showers fell on the extreme north coast on the 1st and 2d, extending south of San Francisco Bay on the 3d; with this exception the weather was fair and pleasant until the 21st, when a trough developed rapidly over the interior of California and the Plateau, giving light but general rains in northern California and Nevada that night. Warnings were issued to the fruit sections at 11 a. m. on the 21st, and the drying fruit and raisins were covered, and but little if any damage resulted.

A low area moving eastward over Saskatchewan on the morning of the 29th caused the rapid development of a secondary depression over northern California, and rain warnings were issued at noon covering California and Nevada. These warnings were continued during the remainder of the month. Rain fell generally in the district, beginning during the night of the 29th–30th, and continuing. Drying fruit and raisins were covered, and but little damage resulted where wooden trays were used, but raisins on paper trays, unpicked grapes, and beans that had been cut were damaged.—*G. H. Willson.*

HURRICANE TRACKS, 1912-1915.

By RICHARD HANSON WEIGHTMAN, Meteorologist.

[Dated: Weather Bureau, Washington, Nov. 1, 1916.]

Steps have been taken to extend the field of the Weather Bureau service in the West Indies and adjacent waters and at the same time to more completely equip the existing individual stations, as well as to secure two daily observations instead of the single daily report sent at present. This action was inaugurated primarily because the opening of the Panama Canal naturally resulted in an increased use of West Indian and contiguous waters as routes for trading vessels and, as a corollary, in the increased importance of meteorological observations and data pertaining to this area not only for climatological but for forecast purposes as well. The most important atmospheric phenomena with which commerce is concerned in these regions are the hurricanes or destructive storms which appear most frequently during the months of August, September, and October, about 90 per cent occurring in these months. In forecasting the move-